19.

A Preliminary Report on the Os Opticus of the Bird's Eye.

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(Text-figures 1-24).

In the eyes of many birds there is a small U- or horseshoe-shaped bone, located in the rear portion of the cartilaginous sclerotic coat of the eye. The open part of the U is toward the upper part of the eye, and through this the optic nerve passes. In some instances the bone may be more or less circular in form and thus completely surround the optic nerve.

Upon the suggestion of Mr. C. D. Bunker of the University of Kansas Museum of Birds and Mammals, an investigation of this bone was made. The purpose of the investigation was to consider its possible taxonomic value, the forms in which it was present, the extent of variation and its probable function.

An examination of the literature revealed that the bone was first described by Gemminger (1853). He noticed that it was present in the eyes of woodpeckers. In his list of 20 forms of European birds he describes and illustrates it in a number that were not woodpeckers. Leydig (1855) adds 13 forms to this list. Later investigators have added a few more forms.

Concerning the function of this element, Gemminger, whose work was mostly with the woodpeckers, writes that this bone is for protection of the optic nerve at its entrance into the eyeball. I am sure that the shock which the eyeball receives as these birds hammer holes in trees must indeed be considerable, but it appears to me that this does not completely answer its purpose.

Gemminger failed to find the bone present in the nocturnal and diurnal birds of prey, in the gallinaceous birds, and what he calls the swamp and swimming birds.

The fine collection of skeletons in the University of Kansas Museum of Birds and Mammals furnished most of the material. I have examined 6,500 skeletons in the above collection. Other material was obtained through the courtesy of Dr. C. R. Schroeder of the New York Zoological Park and from Mr. C. C. Sperry and Mr. Ralph H. Imler of the Food Habits Research Laboratory at Denver.

The method used to secure this very small bone was the dermestid beetle process. Specimens of birds were skinned and drawn, thoroughly dried and then left in the "bug room" to become infested. Within several months the skeletons were entirely cleaned by the beetles and the bones could be picked out of the débris. If, in particular forms, I was certain that the bone was present but I could not find it in the collection of skeletons, the eyes of fresh specimens coming into the museum were saved and dried, and then placed in small glass containers with a number of small

beetle larvae. A week later the inconspicuous bone could be separated from the débris of cast-off beetle remains, if it had ever been present in the sclera of the eye.

Former investigators have described this bone under the misleading name of "the rear sclerotic ring," which would seem to indicate an association with or a relation to the sclerotic ring. In reality there is very little relation between the two, except that they are both located in the sclerotic coat of the eye. I wish to propose the name "*os opticus*" which, I believe, will help to clarify and differentiate the two.

Microscopic sections of the os opticus show that it can be differentiated from the sclerotic ring in that it has a marrow cavity which contains fat and marrow cells and blood vessels. In the sections that I have made of the bone I have always found the cells and vessels. Franz (1934) did not find them in *Motacilla*. The os opticus does not consist of plates like that of the sclerotic ring, although in some instances it has been described as consisting of two or three separate bony elements.

Leydig writes that the origin of the two bony elements of the eye are different. The sclerotic ring, he states, is formed by calcification of the connective tissue, while that of the os opticus is formed by calcification of the hyaline cartilage of the sclera. I have not been able to verify this statement.

There is a great variation in the size, shape and development of the os opticus. In general it is U-shaped or horseshoe-shaped with variations as to the development of the two heels. One heel may be long and well developed and the other one short. There is often very little symmetry and by a comparison of the bone in the right and left eye, Text-figs. 8 and 9, it would often be difficult to conceive of them as coming from the same bird, except for the ground pattern of the U that is easily identifiable. In others they may be exact mirror images and may be definitely designated as left and right.

By securing the eyes of fifty game cocks and using the dermestid method on them, I have been able to obtain a very interesting series of bones from the eyes of this species, although Gemminger and Leydig stated that it was not present in the domestic fowl. In Text-figs. 1 to 6 I have drawn a series of these bones. Text-figs. 1 and 2 show the basal plate which is apparently the first portion to develop. As the series progresses the heels of the horseshoe develop until finally they are in their mature forms.

The bone was apparently not present in all of the eyes, although the birds were mature enough to have been entered in cock fights. This seems to indicate that the development of the os opticus is an age character, and may be formed after the birds are mature. Gemminger and Leydig report that they have found the bone in nestling woodpeckers that they examined. Possibly in forms like the woodpeckers the bone develops early in the life of the bird, and in those forms in which it is not so well developed it appears later in life.

By comparing the different families of birds it appears that the os opticus is best developed in the Picidae, although it is also prominent in the Corvidae and the Fringillidae. In the birds which I have examined, the bone is largest in the Pileated Woodpeckers where the measurement is 1 cm. in the longitudinal axis and .73 cm. in the vertical axis. The measurement of the bone in the fully mature Brown Creeper is .16 cm. by .15 cm. and is the smallest of any of the species represented in my list.

In many instances the bone forms a complete ring around the optic foramen. The optic foramen is a slit whose vertical distance is about twice that of the horizontal distance. This accounts for the U-shape of the os opticus. In those species in which the bone is well developed it is curved to correspond to the curvature of the eyeball.

In woodpeckers, especially, there is quite frequently an enlarged development of bone at the upper portion of the heel. Text-figs. 7 and 9. I have not

Fig. 1

Fig. 2

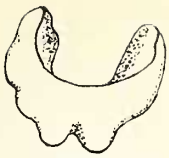

Fig. 3

Fig. 4

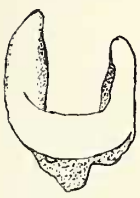

Fig. 5

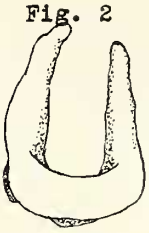

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

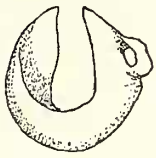

Fig. 11

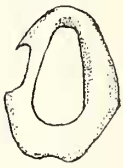

Fig. 12

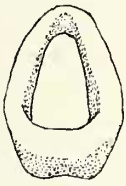

Fig. 13

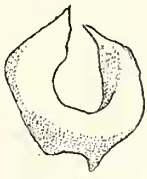

Fig. 14

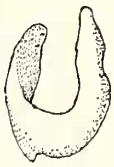

Fig. 15

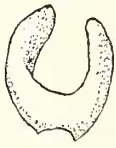

Fig. 16

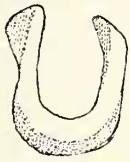

Fig. 17

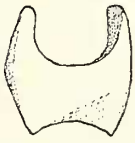

Fig. 18

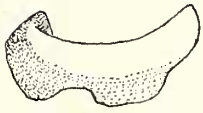

Fig. 19

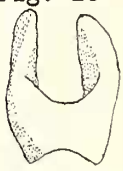

Fig. 20

Fig. 21

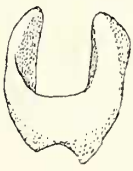

Fig. 22

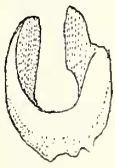

Fig. 23

Fig. 24

TEXT-FIGURES 1-24.

1 to **6.** *Gallus* sp., × 5.5; **7.** *Ceophloeus pileatus pileatus*, × 3; **8.** *Corvus brachyrhynchos brachyrhynchos*, × 5; **9.** *Dryobates villosus villosus*, × 4; **10.** *Buteo borealis calurus*, × 4; **11.** *Colaptes auratus luteus*, × 5; **12** & **13.** *Melanerpes erythrocephalus*, × 5; **14.** *Falco sparverius sparverius*, × 4; **15.** *Sturnella magna magna*, × 5; **16.** *Hedymeles melanocephalus papago*, × 6; **17.** *Tyrannus tyrannus*, × 5; **18.** *Butorides virescens virescens*, × 8; **19.** *Phasianus colchicus torquatus*, × 6; **20.** *Piranga ludoviciana*, × 6; **21.** *Toxostoma rufum*, × 5; **22.** *Dumatella carolinensis*, × 6; **23.** *Sturnus vulgaris*, × 5; **24.** *Dendroica fusca*, × 7.

been able to determine whether this development is separate from that of the bone proper or whether it is only a lobular development of the bone itself. I am rather inclined to think that it is the latter because it is not uniform in position. Sometimes the lobe may be attached to the basal portion of one of the heels or in any position between these two extremes. In any event it does not seem to be a constant development.

Gemminger reports the presence of this element in 20 forms of European birds. Leydig later adds 13 forms to the list. In my material I find it to be present in 152 different forms of North American birds. I feel certain that it is also present in a large number of species belonging to orders represented in my list but which are absent because of lack of material. I have included a list of the forms in which Gemminger and Leydig have reported the bone, and a list of forms that I wish to report.

Reported by Gemminger	Reported by Leydig
Drycopus martinus	*Falco tinnunculus*
Gecinus viridis	*Muscipeta satelles*
Gecinus canus	*Motacilla alba*
Picus minor	*Turdus merula*
Picus medius	*Sylvia phoenicurus*
Picus major	*Troglodytes gigas*
Apternus tridactylus	*Passer domesticus*
Corvus corax	*Fringilla carduelis*
Corvus cornix	*Fringilla caelebs*
Corvus corone	*Sturnus vulgaris*
Corvus frugilegus	*Cassicus phoeniceus*
Corvus monedula	*Trochilus*
Pica caudata	*Hirundo urbica*
Garrulus glandaris	
Silla europaea	
Certhia familiaris	
Tichdroma muraria	
Parus ater	
Pyrrhula rubicilla	

Following is a list of forms in which I have secured specimens of the os opticus.

Butorides virescens virescens	*Tyrannus vociferans*
Accipiter velox velox	*Muscivora forficata*
Buteo borealis borealis	*Myiarchus crinitus boreus*
Buteo borealis calurus	*Sayornis phoebe*
Falco sparverius sparverius	*Sayornis nigricans nigricans*
Falco sparverius phalaena	*Empidonax minimus*
Gallus sp.	*Empidonax difficilis difficilis*
Phasianus colchicus torquatus	*Myiochanes virens*
Syrmaticus reevesi	*Nuttallornis mesoleucus*
Zenaidura macroura carolinensis	*Otocoris alpestris leucolaema*
Columbigallina passerina pallescens	*Otocoris alpestris praticola*
Megaceryle alcyon alcyon	*Hirundo erythrogaster*
Colaptes auratus luteus	*Progne subis subis*
Colaptes cafer collaris	*Perisoreus canadensis capitalis*
Colaptes chrysoides mearnsi	*Cyanocitta cristata cristata*
Ceophloeus pileatus pileatus	*Cyanocitta stelleri diademata*
Centurus carolinus	*Pica pica hudsonia*
Centurus aurifrons	*Corvus corax sinuatus*
Melanerpes erythrocephalus	*Corvus cryptoleucus*
Sphyrapicus varius nuchalis	*Corvus brachyrhynchos brachyrhynchos*
Sphyrapicus thyroideus nataliae	*Cyanocephalus cyanocephalus*
Dryobates villosus villosus	*Penthestes atricapillus atricapillus*
Dryobates villosus monticola	*Penthestes atricapillus septentrionalis*
Dryobates pubescens medianus	*Penthestes gambeli gambeli*
Dryobates pubescens pubescens	*Baeolophus bicolor*
Dryobates scalaris symplectus	*Sitta carolinensis carolinensis*

Dryobates arizonae arizonae
Tyrannus tyrannus
Tyrannus verticalis
Salpinctes obsoletus obsoletus
Mimus polyglottos polyglottos
Mimus polyglottos leucopterus
Dumatella carolinensis
Toxostoma rufum
Toxostoma curvirostre curvirostre
Oreoscoptes montanus
Turdus migratorius migratorius
Turdus migratorius propinquus
Hylocichla mustelina
Hylocichla guttata faxoni
Hylocichla ustulata swainsoni
Hylocichla minima aliciae
Sialia sialis sialis
Polioptila caerulea caerulea
Regulus satrapa satrapa
Corthylio calendula calendula
Anthus spinoletta rubescens
Bombycilla cedrorum
Phainopepla nitens lepida
Lanius ludovicianus migrans
Lanius ludovicianus excubitorides
Sturnus vulgaris vulgaris
Vireo belli belli
Vireo gilvus gilvus
Vireo gilvus swainsoni
Mniotilta varia
Vermivora peregrina
Vermivora celata celata
Compsothlypis americana pusilla
Dendroica aestiva aestiva
Dendroica magnolia
Dendroica coronata
Dendroica auduboni auduboni
Dendroica cerulea
Dendroica fusca
Dendroica striata
Seiurus aurocapillus
Oporornis formosus
Geothlypis trichas trichas
Icteria virens virens
Passer domesticus domesticus
Dolichonyx oryzivorus
Sturnella magna magna
Sturnella neglecta
Agelaius phoeniceus phoeniceus
Agelaius phoeniceus fortis
Icterus spurius
Certhia familiaris americana
Thryothorus ludovicianus ludovicianus
Heleodytes brunneicapillus couesi
Icterus galbula
Icterus bullocki
Euphagus carolinus
Euphagus cyanocephalus
Quiscalus quiscula aeneus
Molothrus ater ater
Molothrus ater artemisiae
Molothrus ater obscurus
Piranga ludoviciana
Piranga erythromelas
Piranga rubra rubra
Richmondena cardinalis cardinalis
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Hedymeles ludovicianus
Hedymeles melanocephalus papago
Guiraca caerulea caerulea
Guiraca caerulea interfusa
Passerina cyanea
Spiza americana
Carpodacus mexicanus frontalis
Spinus pinus pinus
Loxia sp.
Loxia curvirostra pusilla
Pipilo erythropthalmus erythropthalmus
Pipilo maculatus arcticus
Pipilo maculatus montanus
Calamospiza melanocorys
Ammodramus savannarum australis
Passerherbulus caudacutus
Pooecetes gramineus confinis
Chondestes grammacus strigatus
Aimophila cassini
Junco hyemalis hyemalis
Junco caniceps
Spizella arborea arborea
Spizella arborea ochracea
Spizella pusilla pusilla
Zonotrichia querula
Zonotrichia leucophrys leucophrys
Melospiza lincolni lincolni
Melospiza georgiana
Calcarius lapponicus alascensis
Calcarius pictus
Taeniogypio castanotis
Serinus sp.

To date I have not found the bone in a number of families of North American birds, namely: Gaviidae, Pelecanidae, Anatidae, Cathartidae, Tetraonidae, Perdicidae, Meleagrididae, Gruidae, Rallidae, Charadriidae, Scolopacidae, Laridae, Cuculidae, Tytonidae, Strigidae, Caprimulgidae, Micropodidae and Trochilidae. In some of these families the os opticus has been reported but because of the lack of material I am not including them. The most striking gaps in the list are the ones among the water-inhabiting birds and the owls. I have, however, found the bone in the Eastern Green Heron (*Butorides virescens virescens*) and I believe that when I can secure more specimens some of these gaps will be filled.

Possibly the development of the bone is a phylogenetic character in the development of the birds and therefore absent in the more primitive forms. Examination of the eyes of an ostrich and an emu revealed that the os

opticus was not present in those particular specimens of the two forms. I am convinced that in the Order Passeriformes every family is represented by forms in which the bone appears.

It is quite certain that the os opticus can not be used as a diagnostic character in the separation of species because there is too much variation within the same species. There may, indeed, be considerable variance in the two eyes of the same bird.

Upon the assumption that the function of the os opticus is protection of the optic nerve at its entrance into the eyeball, it would be difficult to explain why it is so well developed in the flycatchers, swallows, and other birds whose methods of securing food are quite different from that of the woodpeckers. It would also be difficult to explain why in one order of birds, namely the Falconiformes, it seems to be universally present in the members of the Family Falconidae and only very seldom present in the Accipitriidae.

It appears to be the concensus of opinion of former workers that one of the chief purposes of the pecten is for the nourishment of the vitreous and retina of the eye. I feel that there is a very definite relationship between the pecten of the eye and the os opticus other than that of spatial relationship. In many of the bones, that are exceptionally well developed, there is a small opening on one side and at the base of the bone for the passage of the different blood vessels of the pecten.

It is my intention to continue my investigation of the os opticus, particularly the condition in the nestling, and if possible to ascertain specific changes due to age.

I am greatly indebted to Mr. C. D. Bunker of the University of Kansas Museum who suggested this investigation and who placed at my disposal the extensive collection of bird skeletons for examination. I am also indebted to Dr. C. R. Schroeder of the New York Zoological Park, and to Mr. C. C. Sperry and Mr. Ralph H. Imler of the Food Habits Research Laboratory at Denver, for valuable study material. I wish to thank Dr. E. H. Taylor of the University of Kansas, for helpful suggestions and criticisms.

References.

Gemminger, M.

1853. Ueber eine Knochenplatte im hinteren Sklerotikalsegment des Auges einiger Vögel. *Zeitschrift für Wissenschaftliche Zoologie.* Leipzig, 1853, pp. 215-220.

Leydig, F.

1855. Der hintere Sclerotikalring im Auge der Vögel. *Müller's Archives fur Anatomie.* 1855, pp. 40-46.

Franz, Victor

1934. Vergleichende Anatomie des Wirbeltierauges. In Handbuch der vergleichenden Anatomie der Wirbeltiere. Berlin, 1934, pp. 1133-1134.